



CLEANROOM AIR MANAGEMENT AND EFFICIENCY IMPROVEMENT

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
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TOPICS OF DISCUSSION

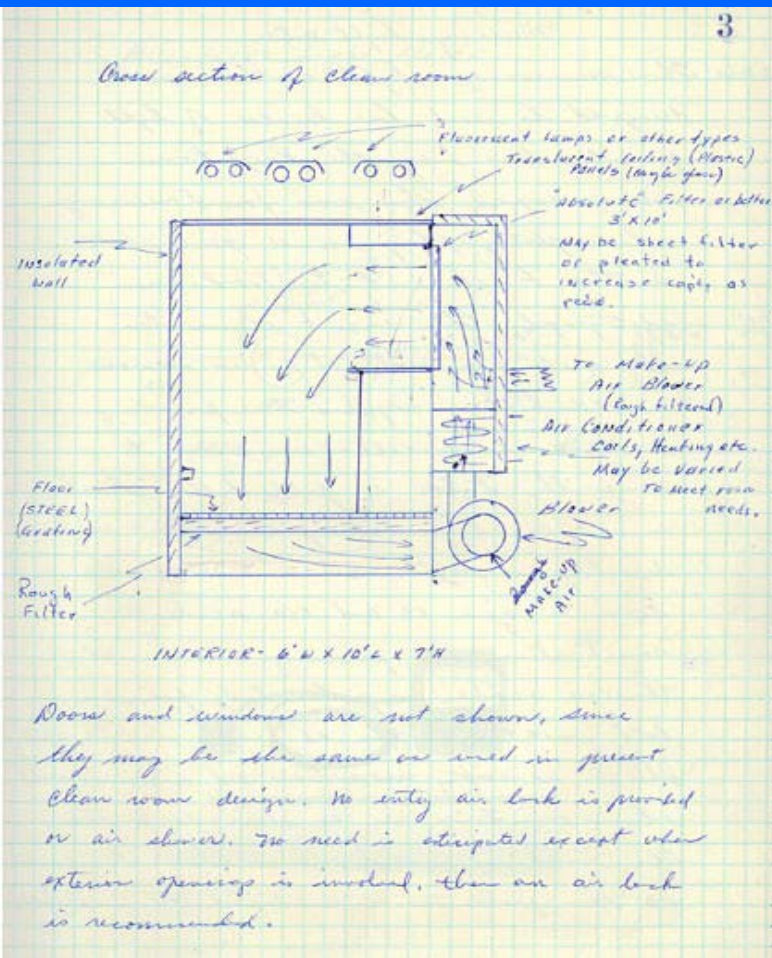
- Introduction to the Microelectronics Development Laboratory
- Existing Cleanroom Airflow Problems
- Cleanroom Modifications
- Results
- Lessons Learned
- Recent Building Energy Improvements



INTRODUCTION TO THE MDL

- Cleanrooms
- CUB
- Support Facilities

SNL CLEANROOMS THEN





Laminar Flow Design

- The “Laminar” or “Unidirectional” concept was developed at SNL by Willis Whitfield in 1961, and a patent was issued in 1964
- SNL helped to develop the 1st Federal Standard 209 in 1963 by J. Gordon King
- The 90 FPM “Rule of Thumb” Laminar Flow Velocity design standard came from these original concepts



SNL CLEANROOMS NOW

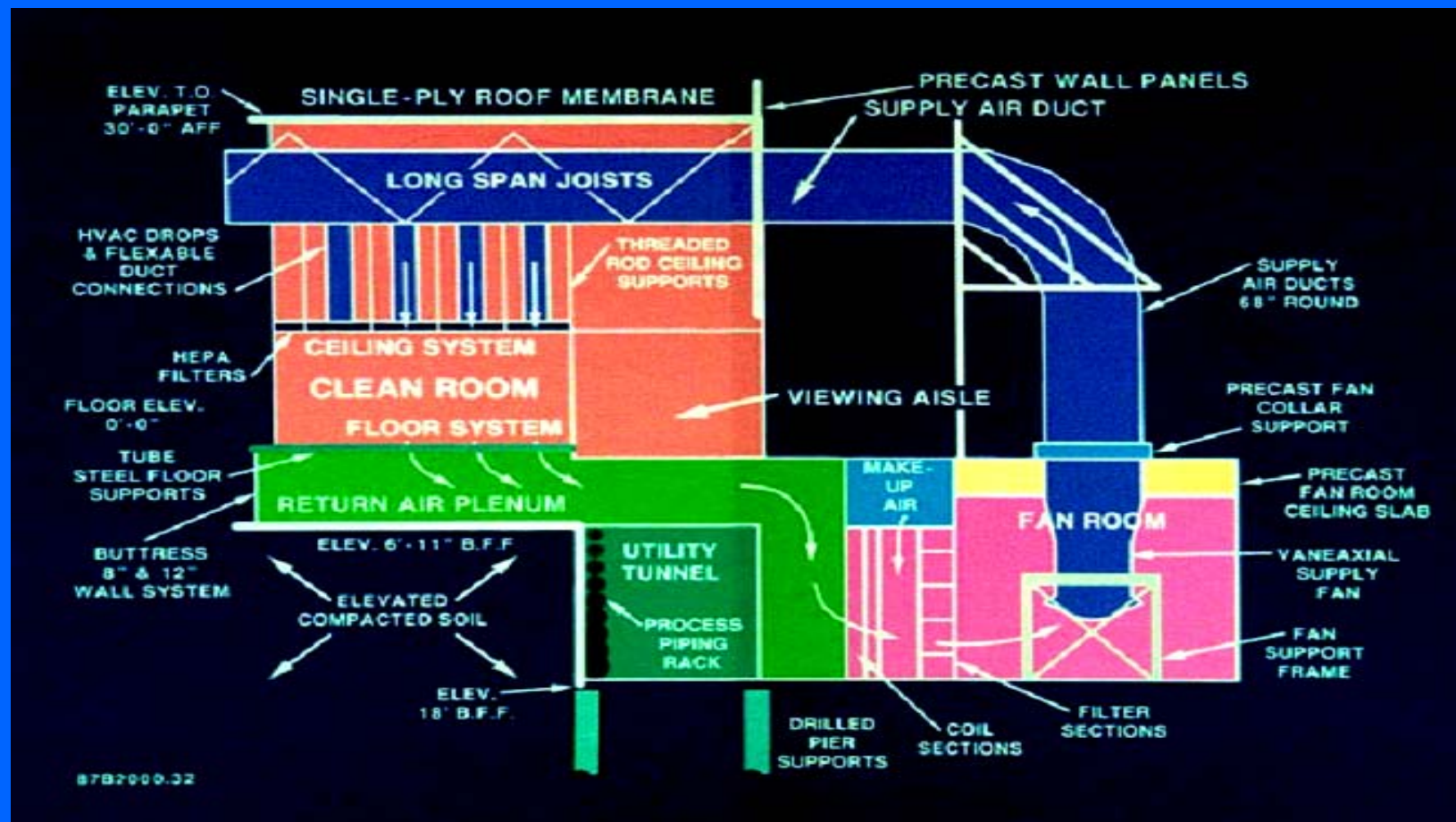




MDL DESIGN BASIS

- The 174,000 GSF MDL was originally designed for 12,500 SF of Class 10 Bays & over 21,800 SF of Utility Chases
- 22 independent bays at 90 fpm laminar flow velocity & chases at 75-120 ACH
- Original certification provided Class 1 Bays and Class 1,000 Chases per Fed Std 209C

BAY/CHASE DESIGN



CUB



Building 858 Systems Upgrades



SUPPORT FACILITIES





SUPPORT FACILITIES

- Chilled Water: 3 each 1,300 ton chillers
- Process Chilled Water: 700 gpm, 3 pumps
- Scrubbed Acid Exhaust: 80,000 cfm, 3 fans and 3 scrubbers
- Solvent Exhaust: 2 each 20,000 cfm fans
- Makeup Air: 122,000 cfm from 4 units
- Recirculation Air: 1.3M cfm with 27 fans
- Ultra Pure Water: 160 gpm now 300 future



EXISTING PROBLEMS

- Customer Funded Retooling Did Not Fund Balancing and Certification
- Bay Velocities Between 50-130 fpm
- Negative Pressure Differentials Between Bays and Chases
- Concerns for Particulate Contamination
- Some Cleanroom Chases Had Higher Temperatures Than Set Point
- Laminar Flow Problems



CLEANROOM MODS # 1

- **Replaced Flex Ducts to HEPA Filters**
- **Sealed Utility Penetrations at Walls and Floors**
- **Developed Room Balance Programs for Exhaust, Supply, Makeup and Pressurization**
- **Balanced Cleanroom Bays to 75 fpm Laminar Flow Velocities Based on Intel Models**



CLEANROOM MODS # 2

- **Balanced Cleanroom Chases to 75 ACH**
- **Certified Cleanroom Bays to Class 10 (ISO 4) and Chases to Class 1000 (ISO 6)**



RESULTS # 1

- **Compared to Recent Fan Settings (Net BHP Reduction of 120 and AES of \$40,112)**
- **Compared to Original Design Basis Fan Settings (Net BHP Reduction of 543 and AES of \$181,727)**
- **Cleanroom Bay Certification of Class 1 (ISO 3) for all Except 1 Bay (Class 10 or ISO 4)**



RESULTS # 2

- **Cleanroom Chase Certification of Class 1000 (ISO 6) for all Chases Using at 75 ACH**
- **Simple Payback of 2 Years for an \$80,000 Test & Balance, and Certification Investment**
- **Certification per Fed Std 209E and ISO 14644-1:1998 for 0.1, 0.2, 0.3, 0.5 and 1.0 micrometer particle sizes for Bays, and 0.5 for chases**



LESSONS LEARNED # 1

- Annual Certification is Important
- Keep Balance Programs Updated
- Initiate Project Sign-Off For Balance and Certification Compliance
- Keep the Cleanrooms Sealed
- Design Future Fabs for Lower Laminar Flow Velocities



LESSONS LEARNED # 2

- **“Right-size” the Equipment Upfront and Save on First Costs and Annual Costs**
- **Energy Saving Projects Work and Regain Capacity**
- **Balance Energy Savings with Reliability**



RECENT IMPROVEMENTS

- Installed VFC's on Low Temp and Primary CHW Pumps (500 ton capacity regain)
- Installed 1Mil Gal Thermal Storage Tank (\$200k/yr energy & operations savings)
- Installed VFC's on Secondary CHW Pumps (125 ton capacity regain summer & 2 hours additional TES usage in winter)
- Installed Low PD Acid Scrubbers and Fan VFC's (regained 8,000 cfm or 10% of total)



FUTURE IMPROVEMENTS

- Upgrade to MTCW System with VSD Chiller, Cold Plate and VFC Pumps
- MTCW Variable Primary Flow Pumping
- Expected Pump Reduction from 3053 gpm to 1960 for the same 600 ton capacity
- Expected Chiller kw/ton of 0.2 to 0.388 part Load to Full load
- Expected Cold Plate Operation of 3,400 hrs/yr out of 8760 hrs/yr